COMMAND INTERFACE USING FINGERPRINT SENSOR INPUT SYSTEM

TECHNICAL FIELD

This invention is directed towards a command interface using the hand, and more particularly to a fingerprint sensor which also functions as a command input.

BACKGROUND OF THE INVENTION

Presently, automobiles are opened, closed, locked and unlocked by keys, door handles and other mechanical latching and unlatching devices. There is also available today for many automobiles a hand-held remote device with buttons thereon. Each button corresponds to a specific command. Currently, there is one button per command with the most common commands including lock doors, unlock doors, unlock trunk, set alarm, or honk horn. The user presses a specific button in order to implement and transfer the specific command to the automobile.

Remote devices currently used do not distinguish one user from another. For example, if the owner of the car drops or loses the remote activation device, a passerby may pick up the remote, which usually has the key attached thereto. Any person holding the remote device may unlock the doors, honk the horn, or perform other functions permitted by the command keys. This has created the unfortunate situation in which the security of the automobile is significantly compromised.

Formerly, if only a key was lost, any person finding the key would be required to test the physical key out on many automobiles and, given the options in a large parking lot, it difficult or impossible to find the automobile which matched the key. With current remote command devices, a passerby who has picked up the remote access device can honk the horn, turn on the lights, or perform other functions which will identify at a distance the automobile. Even at some distance, a hundred feet or more away, a person may press the command buttons which will identify the car for which he holds the key. While this is convenient for a user approaching their own car, any other person can also easily walk up and down the rows of a parking lot, pressing the command button in an

attempt to locate the automobile corresponding to the remote command device. It thus provides an advantage to a thief who has obtained the remote command device and is using it in an attempt to steal the car.

SUMMARY OF THE INVENTION

According to principles of the present invention, a sensing apparatus is provided for sensing the position of a human appendage at specific locations thereon. In particular, a fingerprint sensor is provided for sensing the presence of a finger on the sensor. Further, having identified the presence of the finger on the sensor, it performs fingerprint recognition to determine whether there is a match between the input fingerprint and previously stored fingerprints.

A fingerprint sensor has positioned thereon a plurality of sensing devices. The sensing devices are electrically connected and organized into groups positioned at selected locations on the fingerprint sensor. For example, one group may be on the left hand side and the other on the right hand side. Alternatively, groups may be positioned at the top and bottom or a combination thereof. In one embodiment, the groups are positioned as concentric rings from the center outward.

Once a user activates the fingerprint sensor by placing their finger thereon and being identified as an authorized user, they can then input control commands via the same fingerprint sensor. The commands are input by moving the finger in a selected pattern over the fingerprint sensing device. For example, a movement from the top to the bottom may be interpreted as a command to turn on the lights or lock the door. A movement from left to right may be interpreted as unlock the door.

According to principles of the present invention, the fingerprint sensor is positioned in a housing that also includes an automobile transmitter. An automobile is matched with the transmitter when sold and programmed with the user's identity. Thereafter, when a user wishes to provide command inputs to the automobile he simply first applies his finger to have his fingerprint recognized as an authorized user. After the system recognizes him as an authorized user he can then input various commands to the

system for performance by the automobile. For example, he can lock or unlock the doors, turn on the lights, move the seat position to a selected location, set the alarm, turn off the alarm or perform a number of other functions.

According to one embodiment of the invention, certain functions can be performed prior to the fingerprint recognition. For example, the system may permit locking of the automobile merely by touching the sensor in certain location regardless of the identify of the person performing the touch. This could be true for other selected functions such as setting the alarm system or turning off the lights. These would be functions which are typically in the class that do not compromise the security or operation of the vehicle. Indeed, they may be in the group of operations which enhances and reaffirms the security of the vehicle. Certain other functions can only be performed once a valid fingerprint has been sensed and recognized. For example, functions such as unlocking the doors, turning off the alarm, and setting the seat to the proper position will all require that an authorized user provide a fingerprint pattern and that a match be found before the functions can be performed.

The invention finds use beyond just the class of automobiles. For example, it may also be used as a house entry system, a garage door opening or closing system, turning on lights or any other number of selected functions for which identify of the user is desired to be confirmed prior to performing a certain function.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an isometric view of the use of the invention in conjunction with an automobile.

Figures 2A-2E illustrate various groupings of sensing devices on the substrate according to principles of the present invention.

Figure 3 illustrates possible movement directions that can be sensed according to principles of the present invention.

Figure 4 is a partial cross-sectional, cutaway view of a housing and sensor according to principles of the present invention.

Figure 5 is an alternative embodiment of the housing of Figure 4.

Figure 6 is an electrical schematic of circuits for use according to principles of the present invention.

Figure 7 is a schematic of an alternative embodiment of a circuit according to principles of the present invention.

Figure 8 is a schematic view of a fingerprint sensing device.

Figure 9 is an electrical schematic of a fingerprint sensor according to the prior art.

DETAILED DESCRIPTION OF THE INVENTION

Figure 1 illustrates a command system 10 according to principles of the present invention. The command system 10 includes a transmitting system 12 and a receiving system 14. The receiving system 14 includes an electronic receiver 18, usually embedded and not visible to the naked eye. In this case, the receiving system 14 is shown as an automobile. However, it could also be any other acceptable receiving device for which user security is desired, such as a garage, door, a home, a light or an office.

A user 16 uses the transmitting device 12 in order to send selected commands to the receiving device 14 and perform desired functions. The transmitting device 12 includes a fingerprint sensing system having a plurality of position-sensing devices as part of the array. Fingerprint sensing devices are well known in the art and any acceptable fingerprint or position-sensing device may be used. For example, an acceptable fingerprint sensing device is described in U.S. Patent No. 5,973,623, incorporated herein by reference.

The sensing system 12 includes a plurality of position-sensing devices as best illustrated in Figures 8 and 9. For convenience, a brief discussion of fingerprint sensing technology will now be provided with reference to these Figures 8 and 9. As shown in Figure 8, a plurality of position-sensing devices 2 are organized in an arrays on a substrate 1. The sensing devices 2 are formed in a semiconductor substrate and thus are small so that many hundreds, or thousands, are contained on the single substrate 1. They

are shown in enlarged form on Figure 8 for purposes of illustration. As shown in Figure 9, when the user places their finger 18 adjacent the substrate 1 the fingerprint sensing device 2 determines the position of the finger 18 relative to the sensing device 2. In particular, it senses whether a ridge or a valley or some other feature of the fingerprint is adjacent the position sensor 2. It thus not only senses the presence of either a ridge or a valley but whether or not the finger 18 is sufficiently close to register an input to the sensing device 2.

Once a finger 18 is placed on the substrate 1, the logic unit 7 in coordination with the vertical scan unit 6 and the horizontal scan unit 5 causes sensing to be performed at each individual sensing device 2. The sensing device 2 generates a signal and transmits it to the output 8. The signal is then monitored to perform other functions as explained elsewhere herein.

A power supply 120 is also provided to provide regulated power the substrate 11. In the event the voltage supply includes only power regulator transistors, it may also be on the same substrate 1 or on a separate substrate as discussed later herein. Naturally, the power source itself, such as a battery or other voltage source 95, will not be located on the substrate but will be positioned elsewhere as shown with respect to Figures 4 and 5.

The actual sensing of the finger 18 is performed according to one embodiment using the circuit of Figure 9, which includes two plates 23, 24 of a capacitor for sensing the position of a finger 18. A feedback amplifier 13 is also provided having an input 16 and a reset switch 19 which is controlled according to the supply unit 7. An input capacitor 20 which is charged to a reference voltage from node 21 via power supply 95 may also be used.

The circuit for sensing the presence of the finger, and in particular the ridges and valleys, may be performed by any acceptable sensing technique, and the particular circuit shown in Figure 9 is not required to be used. The signals from all the sensor cells 2 are analyzed or compared to a stored set of reference fingerprint patterns to locate a match. If a match is found, a signal is output, indicating a match. Rather, it is provided only as an illustration of one preferred embodiment for carrying out the sensing according to the

present invention. Any currently acceptable fingerprint sensing or position-sensing devices can be used in place of those shown in Figure 9. The full operation, and detailed description of the circuit of Figure 9 is described in U.S. Patent No. 5,973,623 previously referred to herein.

Referring now to Figure 8, the sensing devices 2 can be conveniently grouped according to a selected arrangement. The grouping can be done by electronic switching or electronic configuration, either hardware or software. The embodiment shown in Figure 8 corresponds to that shown in Figure 2C, the individual position sensing devices 2 being shown in Figure 2 but not being shown in Figure 2C for ease of illustration.. In particular, as shown in Figure 2C, the array of sensing devices 2 is grouped into four preset groups 32, 34, 36, and 38. These groups are electronically segmented to sense the presence of a finger in any one of the quadrants. For example, if the finger is present in quadrant 38 but not present in quadrants 34 and 32, a specific signal is output. Similarly, an output is provided signifying that the finger is present in quadrant 32, but not present in quadrant 36 or 38. The electronic scanning, and sensing of the presence or absence of a finger is carried out as shown in Figure 8 using the horizontal and vertical scan lines, or any other acceptable technique of the many available which are known. Simply recognizing the presence or absence of the finger in the quadrant is acceptable and it is not necessary to perform fingerprint identification. The cells 2 are used only as a position-sensing devices and are not used for fingerprint identification. Thus the same sensors 2 and circuit which were previously used for fingerprint sensing are now used for position sensing.

Figure 2B illustrates a further preferred embodiment for segmenting the cells 2 according to principles of the present invention. The array 1 has the plurality of sensing devices 2 thereon segmented into an upper group 40, and a lower group 42. In addition, they are also segmented into a right side group 44 and a left side group 46. The presence of a user's finger in section 42 can thus easily be distinguished from the presence of the user's finger in section 40. Similarly, sections 44 and 46 can be easily distinguished from each other. Figure 2D illustrates a further alternative embodiment having a plurality

of groups of position-sensing devices organized into different groups 48. According to the embodiment of Figure 1, there are eight different segments of groups of the position-sensing devices 2 thus illustrating that. The number of groups can be any desired number ranging from 1 to 8 or more. For example, in one embodiment, only two groups are provided, upper and lower, or left and right, as can be easily understood by looking at Figures 2B and 2C, thought this embodiment is not shown. Similarly, a left and right side can be combined by software electronics with the top and bottom segmentation into groups.

Figure 2E illustrates a concentric grouping of the position-sensing devices 2. In particular, it includes a central group 50, one outer ring 52, which surrounds and is on the outside of group 50, and a further outer ring 54, which surrounds, and is on the outside of group 52. The polar, coordinate method, or circular groups, is particularly useful to provide certain types of input, as will now be explained with respect to Figure 3.

Figure 3 illustrates possible input command directions 56 and 58 for movement of the finger 18 on the substrate 1. As shown by arrow 58, the user may sweep their thumb from left to right at any position on the sensor 1, such as near the bottom, near the middle, or on the top. Alternatively, the user may move their thumb from top to bottom or from the center outward, if the polar coordinate embodiment of Figure 2E is in use. Figure 3 illustrates, with arrow 56, the concept of first touch location and a last touch location. As can be seen by viewing the end of arrow 56, a user's finger first touched the array 2 in the center portion, group 50. The user's thumb then moved from the center portion in a 45° direction upward, crossing two segments, namely segments 52 and 54. As shown by the raised arrowhead, the user's thumb left the substrate 1 in the upper right hand corner of segment 54, see, for example, Figure 2E. Similarly, arrow 58 represents the user moving their thumb in a horizontal sweep to the left and right across the central portion of the substrate 1 with the user's thumb going up, out of range of the sensor on both the left and right side during the sweep.

According to principles of the present invention, a user is able to provide commands to a system using merely motion of the thumb, or the finger (once again, recall that the thumb is classified as a finger for ease of reference. Indeed, in most embodiments,

the user will find the thumb the most useful finger to use for the present invention, though this does not exclude the use of a finger or, for the disabled persons, without hands, the use of a toe or other identifiable appendage). The sensor system 12 has stored therein a plurality of commands which have been preprogrammed, samples of which will now be provided. For this example, the sensor is used with an automobile. The sensor recognizes a location of a first touch as the finger enters contact with the substrate, and the location of the last touch as the finger leaves the substrate. The sensor also recognizes movement to one location or another while the finger is on the substrate. The user, the commands, and the input for such commands can be any desired configuration as selected by the system designer or the user. For example, if the user enters the touch pad at the lower portion and exits at the upper portion, as would be expected from sweeping their thumb from the bottom to the top. This can indicate that the car should be locked. If the user sweeps their hand from the top to the bottom, this can indicate that the car should be unlocked. Movement from left to right can provide a command input to turn on the lights while movement from right to left can turn off the lights.

Among the more useful commands which can be entered would be those to set the seat position to match the identity of the user who is about to enter the car. Other custom features may include setting the radio to the correct stations, setting the steering wheel to the proper location, or other commands which are specific to a user. Any number of other acceptable commands can be performed, such as roll-up windows, roll-down windows, roll down one or more particular selected windows, engage alarm system, disengage alarm system, and many others which need not be catalogued here but they all fall within the concept of the command interface using the fingerprint sensor system.

A method of operation of the fingerprint sensor system will now be described with reference to Figures 3, 4 and 8. A user presents their finger 18 to the substrate 1 which contains the sensing devices 2 as shown in Figures 4 and 8. The system performs the recognition sequence for a pattern match to determine if the fingerprint is a match to the pattern of a fingerprint previously stored for that of an authorized user. If there is a match, then the controller 7 authorizes the input of a selected group of functions,

such as those previously described. For example, following the correct identification of an authorized user, the user may then use finger movements to unlock the doors as they approach the car. They may then use finger movements to change the seat to a selected position, which has been custom preset to them as an individual since the identity of the user is known from the fingerprint. Through other commands input through their thumb moving across the sensor array 2, they may input a desired temperature control system, whether heating or cooling, a radio station, or other custom details to themselves to begin operation as soon as the car is powered up. As can be appreciated, numerous other functions can also be performed following the fingerprint identification, such as enabling or disabling an alarm system, turning the lights on or off, or other selected functions some of which are customized to the particular user.

According to principles of the present invention, a large number of functions can be performed prior to or in the absence of a fingerprint identification. For example, it is desired that the car will automatically lock itself, or turn the lights off, in the event of an attempted unauthorized use. Accordingly, some of the functions according to the present invention are performed prior to the fingerprint identification taking place. Using the very same sensor elements 2 which also perform the fingerprint sensing. For example, according to principles of the present invention, locking of the car can be performed by random, rapid movement of a finger across the array in addition to being performed by movement in a selected location across the array. Similarly, the lights can be turned off by repeatedly holding a finger on the array. These functions can be performed in a silent fashion, so that the horn is not honked when the car is automatically locked prior to fingerprint recognition. Similarly, the windows can be rolled up, the lights turned off, or other basic service functions performed by any person holding the system 12 prior to fingerprint recognition. However, fingerprint identification is required prior to performing certain selected secure functions.

The usefulness of secure/unsecure grouping of functions can be appreciated in the following explanation. Assume, for example, that the present invention falls from the user's pocket in a parking lot. A passerby, picking up the sensing device, may attempt

to activate the car, so as to locate and thus steal the automobile. If the person places their finger on the array, the only possible things they can do are those which make the car more secure, such as locking the doors, setting the alarm or, alerting the car system that an unauthorized user is attempting repeated entry and thus can make itself more secure. For example, after repeated failures to recognize a print, it could send an alarm via radio transmitter from the automobile to a security company which can then alert the owner that someone is attempting to steal the car. Additionally, a user can hand the keys to a family member, such as a son or a daughter, and ask them to lock the car or turn the lights off and roll the windows up using the remote sensing system. The person may not be an authorized driver of the vehicle, and thus their fingerprint pattern would not match an authorized user pattern. However, they would be able to perform routine functions, such as locking the doors, rolling up the windows and activating the alarm system.

Figures 4 and 5 illustrate possible configurations for the command interface system 12. A housing 60 includes the substrate 1 having an array 3 of sensor devices 2 formed thereon. A printed circuit board 62 supports the substrate 1 to provide both physical mechanical support and electrical connection. Waterproof seals 64 ensure that the sensor array 3 is not damaged by the weather, or other outdoor adverse conditions. The housing 60 includes a power supply 95 and a transmitter and/or receiver unit 110. For example, the receiver unit 110 may be used to receive customization controls, such as adding a user, changing the software commands, or the like.

A controller 7 is connected to the PC board 62 and, in the embodiment shown, is connected to the same PC board, however on the back side. The housing 60 also includes the appropriate mounting, not shown, in order to support and hold the power supply, printed circuit board 62, and transmitter/receiver in the correct orientation. According to the embodiment of Figure 4, the controller 7, which has the circuits thereon to perform the sensing, recognition, storing of command sequences, reference fingerprint patterns, and the like.

Figure 5 illustrates an alternative embodiment of the device of Figure 4. According to this alternative embodiment, the housing 60 includes the power supply 100

and a transmitter 112. In this embodiment, the same substrate 1 includes the sensor array 2, and the electronics for the controller 7. Thus, included on the single integrated circuit, are both the sensor elements, transmitter driving circuits, as well as the recognition units and electronics to drive the transmitter. In some embodiments, it is preferred to have the control logic and drive transmitter circuits in a separate stand-alone substrate as shown in Figure 4, while in other embodiments, having it as a single integrated circuit on the same substrate 1 is preferred.

Figure 6 illustrates an electrical schematic of the circuit according to the present invention as shown in Figure 4. The controller 7 is connected to sensor logic 68, which includes the sensor cells 2 and the appropriate drive logic, including the horizontal scan, the vertical scan, and output sensors, as previously described. It also is connected to the recognition logic 69, which has the appropriate memory for storing reference fingerprint patterns, as well as command sequences as previously described. The power supply 95 provides power through a central control circuit 70, which is in the form of a microprocessor for performing coordination of the various functions as described herein.

Figure 7 illustrates another embodiment of the present invention, as shown in Figure 5. According to this embodiment, the control logic 70 includes within it all of the sensor circuits, the recognition circuits, the memory circuits and other components needed. The sensor array 3 containing the plurality of sensor elements 2 is located in a different portion of the same semiconductor substrate. Control of the transmitter 112 is directly driven from the control logic 70 positioned on the substrate 1.

The present invention has been described with respect to a number of specific embodiments, including the control of an automobile, lights, a garage, or other secured location. Alternative embodiments can be easily provided which fall within the scope of the present invention.